Package for semiconductor components and method for producing the same

[0001] The invention relates to a package for semiconductor components, such as FBGA packages in BOC technology or the like, in which at least the rear side and the side edges of a chip mounted on a substrate are enclosed by a molding covering, the potting compound used for the molding covering being connected to the substrate, in a manner forming a compact unit. The invention furthermore relates to a method for producing such a package for semiconductor components.

[0002] In a series of components such as BOC components or else in CSP (Chip Size Package) components, FBGA (Fine Pitch Ball Grid Array), TBGA (Tape Ball Grid Array) or μBGA components or the like, the chips are mounted on substrates whose dimensions approximately correspond to those of the chips to be mounted. The various designations are in part manufacturer-typical indications and identify differences or subtleties in the structural design. In the interests of a structural height that is as small as possible, in some components the chip rear sides are not covered, rather at most merely the particularly sensitive chip edges are enclosed by a molding compound. This last is effected by dispensing a suitable molding compound (potting compound) around the chip edges. If the chip rear side is also to be concomitantly protected in addition, it is necessary to use complicated printing or casting methods. It goes without saying that the different materials used for the substrate, the chip and the potting compound have in some instances considerably different mechanical properties and, in particular, different thermal expansion coefficients. For the substrate, use is made of the customary printed circuit board materials, such as hard paper or glass fiber materials, in which synthetic resin is usually used as a binder.

[0003] Examples of such semiconductor components are found in US 5 391 916 A, which describes a semiconductor component provided with a potting compound, or in US 5 293 067 A, which describes a special chip carrier for a chip on board (COB) component in order to reduce the mechanical stress.

[0004] Through suitable material selection, the expansion coefficients can be co-ordinated with one another in a certain way such that the difference in the expansion coefficients between the respective material pairing becomes as small as possible.

[0005] However, there is virtually no possibility of complete matching. This has the fatal consequence, particularly in the case of BOC or COB components, that the latter, if they are protected with an additional molding covering, are subjected to an extreme stress during normal use. This stress is essentially based on the "bimetal effect", which results when different materials having different expansion coefficients are joined together in layers.

[0006] In order at least to reduce the stress between the substrate and the chip, the mounting thereof on the substrate is usually effected with the interposition of a tape that compensates for thermal stresses. In any event, there are then still significant differences in the respective expansion coefficients between the material pairings of Si chip/molding compound and molding compound/substrate that are directly in contact with one another. In the worst-case situation, this may result in a separation of the connection and thus possibly the total failure of the component.

[0007] As already mentioned in the introduction, various complicated methods have hitherto been carried out for protecting the chips. Thus, by way of example, dispensing, in order to protect the particularly sensitive chip edges, or printing or molding, in order to achieve a complete protection of the chip including the rear side thereof. However, it has not been possible to eliminate, or eliminate sufficiently, the effects of the thermomechanical stresses between the

material pairings, so that stress-dictated component failures always have to be reckoned with. However, solution approaches such as material and design changes and a tape underlay have caused other problems, such as uncovered fuses.

[0008] Therefore, the invention is based on the object of providing a package for semiconductor components which achieves a significantly higher package loading through lower thermomechanical stress and, at the same time, a significantly better adhesion of the molding covering on the substrate.

[0009] In the case of a package of the type mentioned in the introduction, the object on which the invention is based is achieved by virtue of the fact that the substrate has, at least partially, a sponge-like structure which is provided with porous openings and extends from the surface into the depth, so that molding material can penetrate into the substrate through capillary action.

[0010] This particularly simple solution enables the expansion coefficient of the printed circuit board material to be largely matched to the expansion coefficient of the molding material. As a result, stresses are applied uniformly to the fracture-sensitive semiconductor chip from all sides and said semiconductor chip can no longer flex only in a preferred direction. A further advantage is to be seen in the fact that higher package loadings are made possible by virtue of the lower stress.

[0011] Furthermore, the invention achieves a significantly higher adhesion of the covering material on the substrate since the two materials grow together to a certain extent.

[0012] In order that the production of the substrate according to the invention is configured as cost-effectively as possible, the entire surface of the substrate has a sponge-like structure.

[0013] It is also possible, of course, for the substrate in its entirety to have a sponge-like structure. This means that a particularly large amount of molding material can penetrate into the substrate, with the result that a particularly good adaptation of the thermal expansion coefficients is achieved.

[0014] The sponge-like structure may be produced in a simple manner by partial removal of the epoxy resin portion in the substrate, by using wet or dry etching methods.

[0015] In order to restrict the wet or dry etching to specific regions of the substrate, the latter may be partially covered with a soldering resist mask.

[0016] It is also possible to produce the sponge-like structure by mechanical surface processing of the substrate. In this case, however, the sponge-like region would be limited only to the substrate region directly near the surface.

[0017] In order to achieve the deepest possible penetration of the molding material into the substrate, the structure, comprising the semiconductor chip finally mounted on the substrate, is preheated at least to the melting point of the molding compound before the application of the molding covering.

[0018] As an alternative or in addition the structure, comprising the semiconductor chip finally mounted on the substrate, may be briefly subjected to heat treatment after the application of the molding covering.

[0019] The heat treatment is preferably performed at a temperature around the melting point of the molding compound, or slightly above the melting point, in order to achieve a maximum penetration depth.

[0020] A particular refinement of the invention is characterized in that, before the mounting of the chip, the substrate is partially coated with a thin layer of molding compound and subjected to heat treatment at a temperature around or above the melting point. The molding compound may be applied in a simple manner by printing or dispensing. The heat treatment operation may be performed either directly after the application of the molding compound, or after the application of the molding covering after the conclusion of the mounting operation.

[0021] This refinement of the invention has the advantage that the substrates can be pretreated without influencing the technological sequence of the mounting operation.

[0022] The invention will be explained in more detail below using an exemplary embodiment. In the associated drawings:

[0023] Figure 1 shows a diagrammatic sectional illustration of a BOC component (prior art)

[0024] Figure 2 shows a diagrammatic illustration of a package according to the invention for a BOC component; and

[0025] Figure 3 shows a substrate which has been partially coated with a molding compound and subjected to heat treatment.

[0026] In order that the mode of action of the invention can be illustrated well, the structural design of a customary BOC component will be described first of all. Figure 1 shows such a BOC component constructed according to the prior art in a diagrammatic illustration. The basis for this component is formed by a substrate 1 comprising the customary printed circuit board materials, such as hard paper or glass fiber materials, in the case of which synthetic resin has usually been used as binder.

[0027] A chip 2 is die-bonded on this substrate 1 with the interposition of a tape. The underside of the substrate 1 is provided with conductive tracks (not illustrated) which are connected, on the one hand, to solder balls 4, and, on the other hand, to the chip 2 via customary microwires (not illustrated) which run through a central channel in the substrate 1. This central channel is closed with a bonding channel closure 5 made of a molding material (potting compound) in order to protect the microwires and the active side of the chip 2. The rear side of the chip 2 (at the top in Figure 1) and the chip edges are enclosed by a molding covering 6, the molding covering 6 being connected to the surface of the substrate 1 by adhesion laterally with respect to the chip 2. The molding covering can be produced by printing or dispensing.

[0028] Such a component, then, exhibits the disadvantages described in the introduction on account of the different expansion coefficients and mechanical properties of the individual components which are directly in contact with one another. This forms the starting point for the invention.

[0029] In order to achieve an extensive matching of the expansion components of the molding material and of the substrate and a significant improvement in the adhesion force between molding compound and substrate 1, the substrate 1 is pretreated in such a way that at least its region near the surface acquires a sponge-like structure which extends into the depth and into which the molding material can penetrate during molding. This state is illustrated in Figure 2.

[0030] The sponge-like structure 7 of the substrate 1 can be produced by partial removal of the epoxy resin portion, by using wet or dry etching methods. This wet or dry etching may be restricted, as required, to specific regions of the substrate 1 by said regions being partially covered with a soldering resist mask.

[0031] It goes without saying that the sponge-like structure 7 can also be produced by mechanical surface processing of the substrate, in which case, however, the sponge-like region would be limited only to the region of the substrate 1 that is directly near the surface. In any event, here at least one transition region is produced and a significant improvement in the adhesion force of the molding material on the substrate is achieved.

[0032] Instead of the subsequent processing of the substrate 1, it is also possible, of course, to use a substrate 1 which already acquired a sponge-like structure in the course of its production. Such substrates may also comprise a sintering material in which cavities are produced after sintering by annealing. This can be realized in a simple manner by carbon-containing particles of a suitable size being admixed with the sintering material. These particles then burn during annealing and produce the desired cavities in the substrate 1.

[0033] In order to achieve the deepest possible penetration of the molding material into the sponge-like structure 7 of the substrate 1, the structure, comprising the chip 2 finally mounted on the substrate 1, is preheated at least to the melting point of the molding compound before the application of the molding covering 6. As an alternative or in addition, the assembly may be subjected to heat treatment after the application of the molding covering 6 at a temperature around the melting point of the molding compound or slightly above it.

[0034] In an alternative, before the mounting of the chip 2, the substrate 1 is partially coated with a thin layer of molding compound and subjected to heat treatment at a temperature around or above the melting point of the molding compound (Figure 3). The application of the molding compound to the substrate 1 can be effected in a simple manner by printing or dispensing. The expedient heat treatment operation may be performed either directly after the application of the

molding compound, or after the application of the molding covering 6 after the conclusion of the mounting operation.

[0035] This refinement of the invention has the advantage that the substrates can be pretreated without influencing the technological sequence of the mounting operation.

Package for semiconductor components and method for producing the same

LIST OF REFERENCE SYMBOLS

1	Substrate
2	Chip
3	Tape
4	Solder ball
5	Bonding channel closure
6	Molding covering
7	Sponge-like structure